Order III.—Margaritaceæ. Capillitium not consisting of free elaters, nor combined into an elastic network. Gen. *Margarita, Dianema, Prototrichia.*

Order IV.—Lycogalaceæ. Sporangia forming an æthalium, capillitium consisting of smooth or wrinkled branching colorless tubes. Gen. *Lycogala.*

VEGETABLE PHYSIOLOGY.[1]

Bactericidal Action of Metals.—Under the title, "The effects of various metals on the growth of certain Bacteria," Dr. Meade Bolton, formerly Associate in Bacteriology in Johns Hopkins University, and now bacteriologist to the City Board of Health of Philadelphia, contributes an interesting study to the *International Medical Magazine* for December, 1894. Following up the experiments of Nägeli, Miller and Behring, he has tested the bactericidal effect of various metals The following are some of his conclusions, stated as nearly as possible in his own words. For the most part agar plates were used and bits of metal were put on as soon as the agar was inoculated with the micro-organism and poured. In some cases the metals were absolutely pure, in some cases they were commercial but marked chemically pure, in one set brass foil was used, and a few preliminary experiments were made with impure metals. *Copper.*—In all cases there is around the metal a clear zone, in some cases narrower, in others wider, and then a narrow zone where there is increased growth. This intensified zone does not have as sharply marked borders as with certain other metals. Both the clear zone and the intensified zone vary appreciably in width, even with the same micro-organism. Tests were made with *Staphylococcus pyogenes aureus* and the colon, typhoid, cholera, and anthrax bacilli. *Brass.*—The zones obtained with the different micro-organisms were similar to those obtained with copper. *Silver.*—The results with this metal were somewhat less uniform than with copper and brass. The intensified zone is better marked with silver than with copper or brass, but is also narrower. In some cases with anthrax no clear zone was to be seen, in others there was a wide zone of lessened

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growth or a narrow clear zone followed by one in which the colonies were not as thick as on the rest of the plate. *Gold.*—Purified gold, especially if recently glowed, had no inhibitory effect. In those cases where inhibition was noticed (some plates of anthrax) the gold had not been glowed for several weeks. Miller showed that velvet gold has no antiseptic properties but that certain gold preparations used by dentists, e. g., Pack's pellets, Quarter Century gold foil, and Abbey's non-cohesive foil, inhibited the growth for about 5 mm. all around. *Magnesium.*—Tests were made only on *Staphylococcus pyogenes aureus* and the cholera bacillus. With both these organisms there was a clear inhibitory zone, followed by a zone of increased growth, sharply marked off from the clear zone and gradually fading out on the outside. *Zinc.*—Many experiments were made with ordinary scrap zinc, cast into a sheet, but no note was kept of these. There was a clear zone, however, in every case, and there was probably not much difference between the action of this and of pure zinc. With the latter, all the organisms tested gave a broader or narrower clear zone, surrounded by an intensified zone. With *Staphylococcus p. a.* the clear zone averaged 7 mm. With the cholera bacillus there is a wide clear zone about 1.5 centimeters, and the effect of the zinc is seen as far as 3 cm. away from the metal. With other organisms the clear zone is usually 5 mm., or more, broad, followed by a broad intensified zone that is not sharply marked. *Cadmium.*—With this metal the reactions obtained differ quite strikingly, as a rule. The most peculiar zone observed in the whole set of experiments is that obtained with the micro-organism of anthrax and the pure metal cadmium. In this case there is a perfectly clear zone 5 mm. wide, then an intensified zone of 2 mm. breadth, and a second inhibitory zone 1 mm. wide. In some cases this second inhibitory zone is not entirely free from colonies, but it can always be made out very distinctly. *Mercury.*—There is considerable difference in the behavior of different micro-organisms towards mercury. With *Staphylococcus p. a.* there is a clear zone, about 7 mm. around the metal, followed by a slightly intensified zone which in different cases varies in width from 1 to 3 mm. With *Bacillus pyocyaneus* there is a clear zone 4 mm. broad around the metal and outside an intensified zone, sharply marked toward the clear zone and falling off gradually on the outside. With the cholera bacillus there is a clear zone, 2 mm. around the metal, then a very narrow intensified zone that is well marked. With the bacillus of anthrax there is a broad clear zone, 9 mm. around the metal, surrounded by a very slightly intensified zone that is not sharply marked. With the colon bacillus there

is a clear zone often 7 mm. broad, sharply marked on the inside, then an intensified zone gradually shading off on the outside. With the typhoid bacillus the clear zone is much broader, often 1 cm. across, but the peculiarity is the character of the intensified zone. This is about 2 mm. across, more intense on the outside, away from the metal, and in different cases more or less double, i. e., there is a narrow almost clear zone running all around which divides the intensified zone into two zones. *Charcoal.*—No reaction. *Silicon.*—Do. *Aluminum.*—Do. *Niobium.*—Do. *Antimony.*—With *Staphylococcus p. a.* this metal gives a clear sharp zone about 1 cm. wide, then a zone about 5 mm. wide where there is diminished growth. In one of the plates there was only a very narrow clear zone. With the colon bacillus there is a breadth of 8 mm. where the growth of the colonies is somewhat thinner than on the rest of the plate, but no clear zone. The intensified zone is quite distinct and about 1 mm. broad. With the typhoid bacillus there is an almost clear zone of 1 cm., then an intensified zone 2 mm. broad. With the anthrax bacillus there is a perfectly clear zone 1.8 cm., then an indistinct intensified zone. With the cholera bacillus there is no sharply marked clear zone, but diminished growth can be made out as far as 1.5 cm. to 2 cm. around the metal. *Bismuth.*—*Staphylococcus p. a.* with this metal gives a clear zone about 2 mm. wide and an indistinct, narrow, intensified zone. With anthrax cultures there is a clear zone 1 mm. wide. Pyocyaneus, cholera, typhoid and colon bacilli gave no reaction with bismuth. *Iron.*—A bright polished wire nail gave a clear zone about 7 to 10 mm. wide with the typhoid bacillus and with the colon bacillus. Other organisms were not tested. Behring is said to have obtained negative results with iron. *Nickel.*—Pure nickel failed to give any reaction with most of the micro-organisms tested. *Platinum.*—Platinum wire and platinum black failed to give any reaction with any of the micro-organisms tested. From the above results it is notable that it is precisely those metals that are resistent toward chemical reagents in general which fail to show any reaction or do so only to a limited extent. On the other hand, metals that are readily attacked by chemical reagents all exhibit a marked inhibitory action on the growth of the bacteria. The effect is, therefore, probably due to a solution of the metal in the medium, and putting bits of metal on the cultures is really equivalent to the addition of a small amount of that salt of the metal formed by the action of the nutrient medium. Traces of the metal may, moreover, be detected by chemical reagents in the nutrient medium surrounding the metal. The explantion of the clear zones is thus quite

evident, but the explanation of the intensified zones and of the second inhibitory zone, sometimes seen, is not very apparent. It is probable, however, that the dissolved oxides or salts of the metals are in too great concentration in the clear zone, and that the trace present in the intensified zone may stimulate growth. This does not explain the second inhibited zone. The length of time it is necessary to leave the metals in contact with the agar, in order to develop the inhibitory action was tried with brass, copper, cadmium and zinc. Plates of *Staphylococcus p. a.* were made in the usual way and the metals put on and removed at various intervals. With cadmium there was a clear space where the metal had lain and for 1 mm. around, where the metal had been left on for a minute. Where the metal had been left on for 3 or 4 minutes or more the clear space usually extended over 3 mm. around where the metal had lain. With zinc the results are similar as regards length of time, but the edges of the clear zone are not well defined and there is an intensified zone that is not apparent with cadmium. With brass there was no effect produced by leaving the metal on for 36 minutes; after this there was more and more marked inhibition up to 50 minutes, but no clear space except where the metal was on for a longer time than this. With copper no visible effect was produced in less than 36 minutes. After this time there was more and more marked inhibition, but only where the metal had been allowed to lie on for 50 minutes was there a clear space. The whole paper is very suggestive and is commended to experiment station workers and all who have to deal with problems relating to fungicides and germicides. Probably the increased development and prolonged activity of chlorophyll in foliage sprayed with Bordeaux mixture is also attributable to the stimulating effect of the minute traces of copper that must pass into the leaves. The paper contains 10 pages and 11 figures, and has been distributed as a reprint.—ERWIN F. SMITH.

ZOOLOGY.

Antivenine.—Prof. Fraser has laid before the Royal Society of Edinburg some important results of his admirable experiments on snake poisons and their antidote. His method is to ascertain the minimum lethal dose for an animal, to begin experimenting upon a similar animal with a smaller dose. After a short interval he increases this